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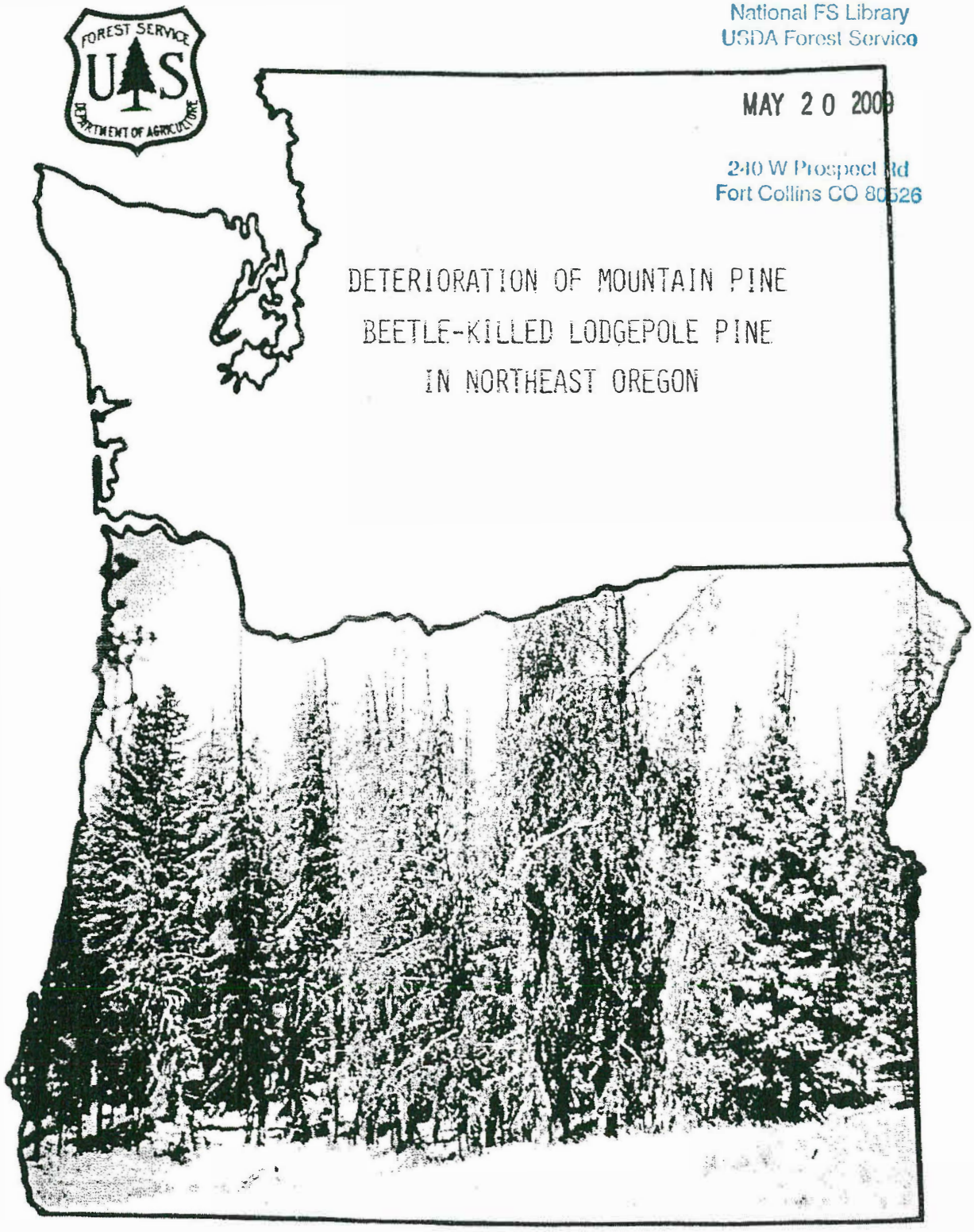

R6-86-13

DETERIORATION OF MOUNTAIN PINE BEETLE-KILLED LODGEPOLE PINE IN NORTHEAST OREGON

by

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ABSTRACT

The mountain pine beetle, Dendroctonus ponderosae Hopkins, is a periodic forest pest in most mature lodgepole pine (Pinus contorta Dougl. ex Loud.) stands. Outbreaks develop in lodgepole pine stands after the trees reach 80 to 100 years of age. Mountain pine beetle outbreaks typically start in large-diameter trees because they provide the food and living space necessary for brood development. Outbreaks continue until the large-diameter component of the stand is killed; the average diameter of the living residual is usually below 8 inches DBH (Safranyik 1974). Trees smaller than 4 inches in diameter are attacked only occasionally.

Stands in the Blue Mountain outbreak area became established in the 1860s following fires that destroyed the former stands. Losses to mountain pine beetle were estimated to be in excess of 116 million board feet in this area between 1972 and 1974.

The rate of deterioration of beetle-killed lodgepole pine is an important consideration in developing salvage and fire management plans. This information was lacking when the outbreak erupted. Consequently, an evaluation that could provide some of this information was designed and initiated in 1975. The evaluation area included portions of the Wallowa-Whitman and Umatilla National Forests.

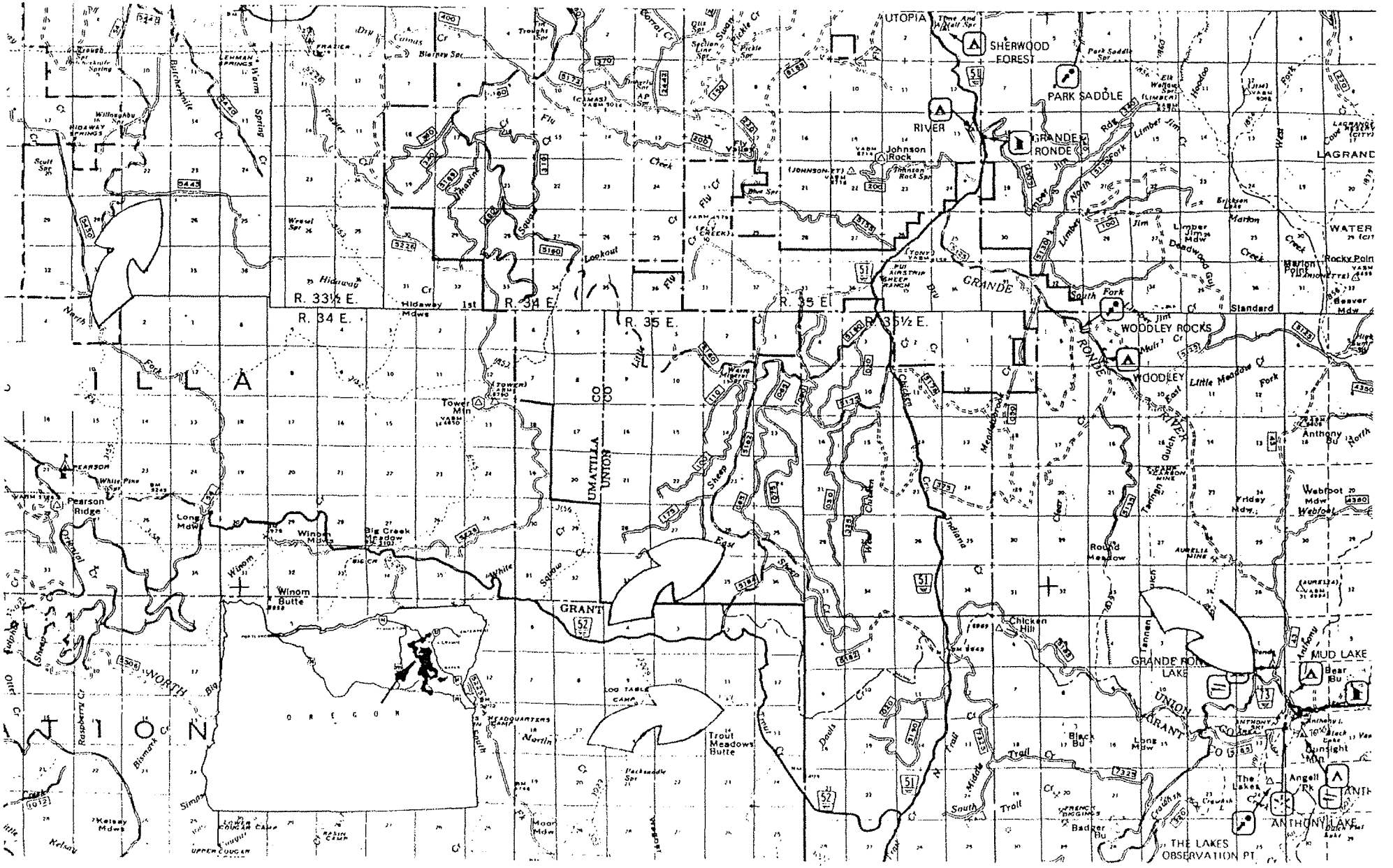
OBJECTIVES

The main objectives of this evaluation were threefold: (1) To provide land managers with an estimate of the deterioration that will develop in standing mountain pine beetle-killed lodgepole pine trees, (2) to provide an estimate of the deterioration that will develop in down mountain pine beetle-killed lodgepole pine trees, and (3) to provide an estimate of the length of time mountain pine beetle-killed lodgepole pine trees remain standing.

MATERIALS AND METHODS

The evaluation area is within the boundaries of the 1973/1974 mountain pine beetle outbreak, with plots placed specifically in areas of extensive mortality. Plot locations were, as nearly as possible, on sites that had a high probability of being protected through the next 20 years (Figure 1). This was accomplished by establishing them on sensitive sites, such as near

Figure 1


R. 33½ E.
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UMATILLA CO
UNION CO
GRANT CO
OREGON
UTOPIA
SHERWOOD FOREST
PARK SADDLE
RIVER
GRANDE RONDE
Johnson Rock
WOODLEY ROCKS
WOODLEY
Tower Mtn
Pearson Ridge
Winom Butte
Big Creek Meadow
Trout Meadows Butte
Chicken Hill
MUD LAKE
ANTHONY LAKE
THE LAKES OBSERVATION PT.

recreation areas, streams, or natural meadows. Additionally, study area signs were appended to peripheral trees, and maps with legal descriptions and directions for relocation were entered into the Pacific Northwest Region's Total Resource Information (TRI) computer files. Three areas were located for replication of plots in such a way that, if a forest fire occurred, the likelihood of all three sites being consumed would be minimized.

Plots in each of the areas were located so that trees growing on sites covering the range of conditions could be sampled. These included wet or dry, flat or sloped sites. An attempt was made to sample all dead trees in the immediate vicinity of each plot. Since sampling was accomplished over a span of years, relocation of plot trees was essential. To achieve this end, live trees were selected as plot centers and were located throughout the area in such a way that mountain pine beetle-killed trees in the immediate vicinity and within easily visible distance would be considered "in" trees for that plot. Consequently, plots were variable in size and number of "in" trees.

Plots were numbered consecutively and pinpointed on an aerial photo. Trees killed by mountain pine beetles in 1973 or 1974 and located within plots were numbered consecutively by area and recorded by the range of numbers in each plot.

Individual trees were numbered in a clockwise direction, starting from north, by appending an engraved aluminum tag at DBH. The tag was then encircled with orange paint for visibility. All tags faced plot center. Orange paint was placed as an "X" at the base of each plot tree to aid in relocation of down trees.

One-hundred and fifty trees were selected and marked in each area, in each size class, unless that many could not be located in reasonable time with reasonable effort. Selection in this manner would result in a maximum of 900 trees per area and 2700 trees overall. Size class and diameter range included:

Size Class	Diameter (in.)
4	3.0-4.9
6	5.0-6.9
8	7.0-8.9
11	9.0-12.9
15	13.0-16.9
19	17.0 +

SAMPLING

The number of trees sampled periodically in each size class and area was determined by the total number of trees in the size class and the number of sampling periods. Data recorded for each tree when sampled was area, plot, tree number, DBH, age counted on the stump, date cut, height to a 3-inch diameter top, total tree height, number of bolts, and length of last bolt. Sampled trees were felled 1 foot above the ground and cut into 8.3-foot bolts up to the top bolt which could be any length up to 8.3 feet. At each cut, a 2-inch cross-sectional slab was removed for examination and photographing as described by Thies and Harvey (1979). Prior to photographing, any advanced decay associated with mountain pine beetle activity was located by ease of

penetration of a knife tip. Ease of penetration was based on dropping a large, folding sheath knife 1 to 2 inches to the slab surface and was mostly a judgment call. Advanced decay was assumed to have resulted subsequent to mountain pine beetle activity if it appeared to originate at the outer edge of the tree and extended inward. Decay was delineated with a black felt tip pen so that individual measurement could be made from the photograph. Heart rot also was delimited.

When the tree was felled, it was left in the position it fell so that it could be assessed for future decay in that position. These data could then be related to decay occurring in natural fall-down, although somewhat pessimistically since there would be many end cuts through which decay organisms could enter. The direction in which the tree was felled was primarily based on ease of getting it to the ground, so that some bias was introduced in the otherwise preferred random location of down logs. Overall, an attempt was made to vary the terrain on which the trees landed so that a range of ground conditions existed and future decay could better be related to natural fall-down.

At periodic intervals after felling, 142 of the down trees were again sampled to determine initiation or continuation of decay while down. For down trees that were sampled in the second and subsequent years of the evaluation, a cross-sectional slab was removed from the center of each bolt, except the top bolt if it was too small to cut again. The portion of the cross section farthest from the ground was indicated by an arrow on the slab and any advanced decay was delimited, as on the cross sections for felled trees, prior to photographing.

To determine the length of time mountain pine beetle-killed trees would remain standing, 855 trees killed in 1974 were numbered and tagged in three locations separate from the plot tree locations. One was located near East Sheep Creek and the remaining two were located near Anthony Lake recreation area. Orange paint was used to encircle the tags and mark the base of trees to make relocation easier. Trees were located along a series of transects and consecutively numbered in such a way that the tag on the next tree was easily visible from the previous tree. After the first year, when trees were measured and categorized by 2-inch diameter class, the only data collected was the year in which they fell. Tree sizes varied randomly throughout the range for dead trees.

Sampling, as described, was performed annually from 1975 to 1979 and was thereafter suspended. In 1985, an additional sample was taken to ascertain if the lapse in data collection had fatally damaged the goals of the evaluation. For the 1985 sample, the data collection scheme was altered, due to time and manpower limitations, yet was performed in a manner that was felt would be compatible, albeit somewhat less precise, with previous sampling.

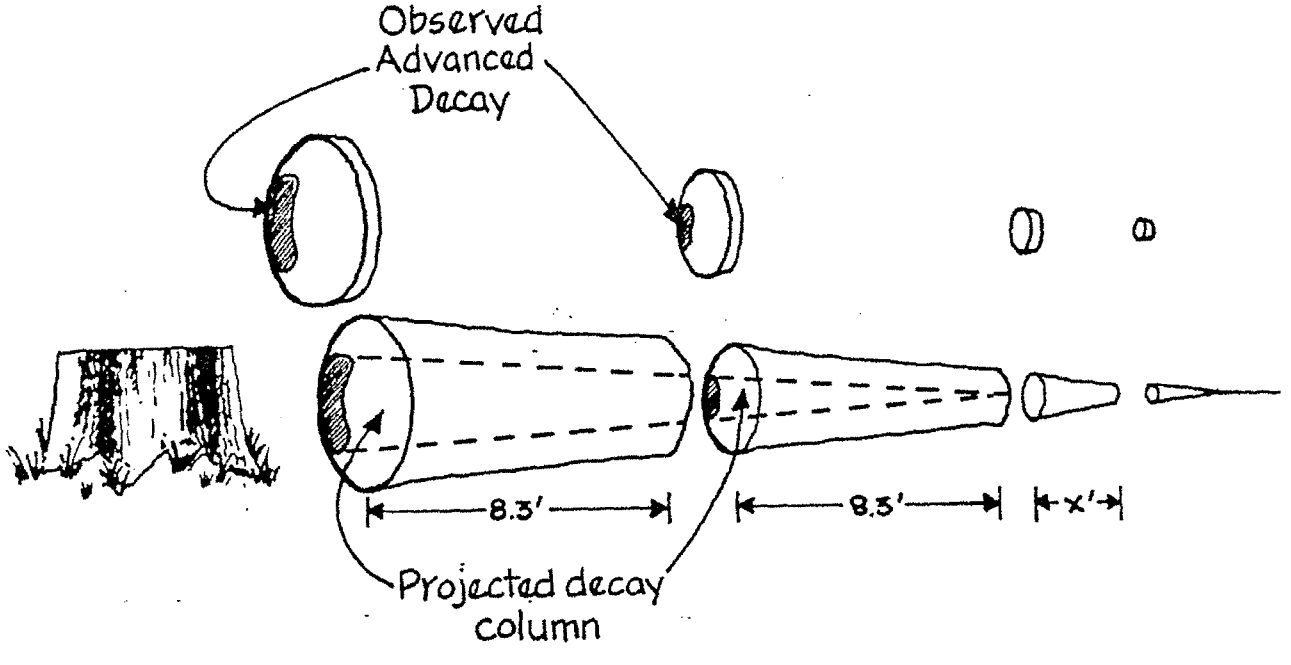
During 1985, standing trees that were felled were cut 1 foot above the ground as previously. However, if no postmortem decay was observed, no more cuts were made. If decay was seen, an additional cut was made 2 feet further up the log. Visual estimates of the percentage of decay on the cut surface were recorded, and extrapolation for the whole tree was made. Diameter at breast height and tree length, to a 3-inch diameter top, were also recorded.

For down trees, a visual estimate of percent of advanced decay on the cut surface of the center of the bottom bolt and the center of the top bolt was recorded. The exception to this occurred if the top section was either too small to cut again or was missing, in which case the next bolt closest to the top of the tree was sampled.

VOLUME COMPUTATIONS

For the first 5 years of sampling data, volume computations were based on expanded area from photographs of cross-sectional slabs. As described by Thies and Harvey (1979), most photographs were taken from a fixed distance with a known scale. Where distance varied because of cross-sectional size, a tape measure was placed in view and photographed so that an appropriate scale could be calculated. The area of each cross section was measured on the photograph with an electronic digitizer coupled to a desk-top computer. Using a known scale, the measurement was expanded to represent actual square inches of cross-sectional surface area. Thus, using Smalian's formula for volume, $V=(AB/2 + AT/2)H$ where AB = area of the base, AT = area of the top, and H = height of the section, the volume for each section could be calculated and combined to get the total volume of the tree to a 3-inch diameter top. The volume of advanced decay was calculated similarly, except that the column of decay was described as a cone, ending at the next cross section beyond which any decay was observed (Figure 2).

Figure 2 - Illustration of log sectioned for calculation of sound and advanced decayed volume using Smalian's formula for volume.



RESULTS

During the course of this evaluation, 416 trees were felled and examined. Trees ranged in size class from 4 to 19. Overall, the mean DBH was 9.9 inches, the mean age was 101.2 years, the mean height was 67.3 feet, and the mean volume was 19.3 cubic feet. Table 1 displays the statistics for trees by area and size class.

Table 1 - Statistics for deterioration of evaluation trees by area and size class.

AREA/SIZE	$\bar{x}$ DBH	$\bar{x}$ AGE	$\bar{x}$ HEIGHT	$\bar{x}$ GROSS VOL.	$\bar{x}$ NET VOL.	PERCENT	n
East Sheep Creek							
4	4.31	62.33	40.21	1.65	1.65	100	9
6	6.01	68.33	52.05	4.62	4.62	100	49
8	7.74	71.70	59.81	8.64	8.63	99.88	53
11	10.04	86.00	69.49	17.26	17.17	99.48	40
15	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0
TOTAL $\bar{x}$	7.58	73.84	58.69	9.20	9.17	99.67	151
Trout Creek							
4	0	0	0	0	0	0	0
6	5.89	111.38	46.64	4.34	4.17	96.08	26*
8	7.94	116.43	61.42	10.42	10.25	98.37	52*
11	10.84	137.86	70.97	21.22	20.51	96.65	56*
15	14.63	128.69	75.30	36.30	36.20	99.72	50*
19	19.56	122.53	77.03	53.79	53.79	100	15
TOTAL $\bar{x}$	11.05	125.13	66.90	22.44	22.14	98.66	199
Hidaway Creek							
4	0	0	0	0	0	0	0
6	6.00	60.00	55.40	7.14	7.14	100	1
8	8.35	87.50	79.75	15.49	15.49	100	10
11	10.61	93.49	88.41	26.97	26.96	99.96	35
15	14.21	91.75	92.03	46.40	46.15	99.46	16
19	20.18	94.50	102.75	85.72	85.72	100	4
TOTAL $\bar{x}$	11.65	91.71	88.34	33.20	33.14	99.82	66
GRAND TOTAL $\bar{x}$	9.89	101.21	67.32	19.34	19.18	99.17	416

* - For 6,8,11, and 15 inch-classes, the n used for calculating $\bar{x}$ age and height was 24,49,49, and 48, respectively.

Fifteen trees (3.6 percent) exhibited advanced postmortem decay when they were felled. Of these, two exhibited additional decay after being down for a period of time. The range of years standing for the trees exhibiting decay when felled was 4-11 with a mean of 5.8 years and a mean decayed volume of 0.5 cubic feet. Forty-two trees were exhibiting decay only after being down for a period of time. The range of years down was 1-10 with a mean of 7.6 years and a mean decayed volume of 1.2 cubic feet. Table 2 shows cubic foot volume of decayed wood in affected sample trees, by area, years standing and/or down, and status when decay was observed.

Table 2 - Decayed volume in affected sample trees, by area, years standing and down, and status when decay observed.

AREA	YEARS STAND.	YEARS DOWN	n	CUBIC FOOT DECAY STAND.	DOWN	STAND & DOWN
East Sheep Creek	5	-	2	0.22	-	-
	4	-	3	3.81	-	-
	1	3	1	-	0.11	-
Trout Creek	11	-	3	0.15	-	-
	5	7	1	-	1.07	-
	5	6	11	0.17	6.48	0.65
	5	-	1	1.80	-	-
	4	7	4	-	5.90	-
	4	-	2	0.69	-	-
	3	9	1	-	2.20	-
	3	8	5	-	5.67	-
	3	1	1	-	0.09	-
	2	9	8	-	6.29	-
	1	10	10	-	19.45	-
	1	3	1	-	1.60	-
Hidaway Creek	5	-	1	0.83	-	-
	4	-	1	0.25	-	-
	1	3	1	-	3.28	-
TOTAL			57	7.92	52.14	0.65

Overall, 57 trees (13.7 percent) that were sampled exhibited decay either at felling or subsequently. Of the more than 8000 cubic feet of volume sampled, less than 1 percent was lost to advanced decay after at least 11 years from time of death.

A large portion of the trees in the East Sheep Creek area, marked to evaluate rate of fall-down, were harvested by the time of the 1985 examination. Therefore, this fall-down plot was eliminated from further sampling. To add to the data base from the Anthony Lakes plots, the first 127 trees in the Trout Creek plots that were not cut were examined. Of these, 44 (34.6 percent) were down. The total for the Anthony Lakes trees was 64 down out of 300 examined. Together, this amounts to 25.3 percent fall-down after 11 years dead. Only one tree fell in the first 5 years (in 1979) of the evaluation.

DISCUSSION

During the early stages of the evaluation, it was evident that most lodgepole pines had begun to check from drying. Usually, multiple checks were appearing and nearly all trees had been infected with a blue staining fungus which resulted in nearly 100 percent of the sapwood becoming discolored in the first two 8.3-foot logs. Harvey (1979) reported that, by the time easy identification of attacked trees can be made from crown symptoms, about 9 or 10 months after initial attack, more than 50 percent of the cubic foot volume or nearly 100 percent of the sapwood is stained. After discussions with industry representatives, it became apparent that the predominant use for this salvable commodity was pulp or chips. In either product, the checks did not affect the value, and the staining, while possibly requiring additional bleach in a manufacturing process, was not likely to result in a reduced value. Incipient decay does not significantly affect the quality of chips and pulp and, since there is sometimes no indication of its presence and/or it is easily overlooked, the decision was to identify only advanced decay. In advanced decay, wood is changed completely in appearance and structure, and the continuity of wood tissues is destroyed. Advanced decay was easily identified, and its extent was determined with a knife tip, as previously noted. Advanced decay in the form of heart rot, while usually noted and measured, was not part of this evaluation and is not reported.

As seen in Table 2, advanced decay was not recorded in standing dead trees until the fourth year after death. During the 1985 examination, 10 trees standing dead for 11 years were sampled. Of these, three had observable advanced decay, which amounted to less than 0.08 percent of the sampled volume, and only 0.23 percent of the gross volume of the three trees.

Thus, with the low fall-down rate and the extremely low rate of development of advanced decay in standing dead trees, it appears that salvage of mountain pine beetle-killed lodgepole pine for fiber in northeastern Oregon will not be significantly affected by advanced decay for at least 10 years after death, and possibly for substantially longer, owing to the moderate to slow rate of development of advanced decay in down logs.

ACKNOWLEDGEMENT

During the 6 years in which data were collected, many people have been instrumental in bringing this survey to its current state of completion, some working several summers at the often very demanding jobs of felling, bucking, measuring, and photographing trees. In order to acknowledge all with no slight to efforts expended, I am listing names of those involved in sampling in alphabetical order and offering my sincere thanks to Bob Aldrich, Paul Brewster, Greg Filip, Cathy Flannigan, Bill Lane, Kathy Robbins, Craig Schmitt, and Scott Worrell. To those unnamed persons who assisted in other aspects of the survey, I also offer a sincere thanks. Special thanks is extended to Walt Thies, who conceived this project but was unable to initiate it, due to a job change.

REFERENCES

Harvey, R. D., Jr.
1979. Rate of increase of blue-stained volume in mountain pine beetle-killed lodgepole pine in northeastern Oregon, U.S.A. Can. J. For. Res. 9(3):323-326.

Safranyik, L., D. M. Shrimpton, and H. S. Whitney
1974. Management of lodgepole pine to reduce losses from the mountain pine beetle. Pac. For. Res. Ctr. For. Tech. Rpt. 1.

Thies, W. G. and R. D. Harvey, Jr.
1979. A photographic method for measuring tree defect. Can. J. For. Res. 9(4):541-543.

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